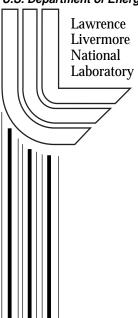
# Effects of Fluid Distribution on Measured Geophysical Properties for Partially Saturated, Shallow Subsurface Conditions

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### Research Objective

Our goal is to improve geophysical imaging of the vadose zone. We will achieve this goal by providing new methods to improve interpretation of field data. The purpose of this EMSP project is to develop relationships between laboratory measured geophysical properties and porosity, saturation, and fluid distribution, for partially saturated soils. Algorithms for relationships between soil composition, saturation, and geophysical measurements will provide new methods to interpret geophysical field data collected in the vadose zone at sites such as Hanford, WA.

# **Research Progress and Implications**

This report summarizes work after 10 months of a 3-year project. We have modified a laboratory ultrasonics apparatus developed in a previous EMSP project (#55411) so that we can make velocity measurements for partially-saturated samples rather than fully-saturated or dry samples. We are testing the measurement apparatus using standard laboratory sand samples such as Ottawa sand samples. Preliminary results indicate that we can measure both compressional and shear velocities in these sand samples. We have received Hanford soil samples (sands from split-spoon cores from an uncontaminated site) and expect to make ultrasonic measurements on them also. We have used the LLNL x-ray facility to perform x-ray computed tomography (XCT) imaging for several partially-saturated Ottawa sand and Lincoln sand samples, and have also used the DOE Advance Photon Source at Argonne National Laboratory to make higher-resolution images of some sand samples. Preliminary results indicate that we can image amount and distribution of fluids in homogeneous sand samples. Continuing work from the previous EMSP project, we are testing a new data analysis method for seismic data that is expected to improve interpretation of

seismic data from the vadose zone by showing how partial saturation affects seismic parameters. Our results suggest that the planned approach for this research is appropriate, that microstructure is an important factor for measured geophysical properties, and that seismic field experiments should be designed to collect both compressional and shear wave velocity data. We are also continuing to develop algorithms for relating geophysical properties to soil composition and hydrological parameters. The lead P.I. attended the EMSP Principal Investigator Orientation Meeting held in Richland, WA, in November, 1999, and presented preliminary results at the Advanced Vadose Zone Characterization Workshop that was held in Richland, WA, in January, 2000, as well as the EMSP National Workshop held in Atlanta, GA in April, 2000. Results have also been presented at scientific meetings and in journal papers as listed below.

### Planned Activities

We plan to continue making laboratory measurements of compressional and shear velocities for partially saturated soils at low pressures, in the first two years of this project. We will also continue to make XCT images of partially saturated samples during the first two years of this project. In the second year, we will focus on using rock physics theories and laboratory measurements to relate measured velocities to saturation and composition for soils. This work also will make use of results from a previous EMSP project (#55411) and other available geophysical data. In the second and third years of the project, we will focus on developing algorithms for relationships between composition, saturation, and geophysical measurements.

We are also networking with other current and former EMSP project P.I.'s (e.g., C. Carrigan, LLNL, E. Majer, LBL, D. Steeples, U. Kansas, R.J. Knight, Stanford/U. British Columbia) to plan possible future collaborations on field experiments to test the lab and theory results of this EMSP project, since this EMSP project is developing methods for improving interpretation of field experiment data used for subsurface imaging. The P.I. for this project provided advice about geophysical field experiment design for subsurface imaging at the Hanford site, at the Advanced Vadose Zone Characterization Workshop and in follow-up discussions.

This project and the previous project for which it is a continuation (#55411) produced two patent applications (listed below).

### **Information Access**

Copies of many of these documents may be viewed online or downloaded at the URL http://www.llnl.gov/tid/lof/

by performing a search using the UCRL number of the document or the author name.

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